REPORT OF THE FIRST MEETING OF THE EUROPEAN CONTACT GROUP ON THE USES OF ISOTOPES AND RADIATION IN AGRICULTURAL RESEARCH

Held in Wageningen, Netherlands
10-14 December 1956

Food and Agriculture Organization of the United Nations

Beginning in January 1955, reports of FAO Meetings held as part of the Program of Work of the Agriculture Division, are being issued in the present form.

Reports are numbered chronologically within each calendar year.

The following reports of meetings concerned with the general organization of agricultural research have been issued by FAO:

Report of the First Meeting of the Sub-Committee on Agricultural Research, 22-25 November 1954 (mimeographed).

Report of the Second Meeting of the Sub-Committee on Agricultural Research, 22-25 August 1955 (mimeographed).

Organization of Agricultural Research in Europe, Development Paper No. 29.

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EUROPEAN COMMISSION ON AGRICULTURE

SUB-COMMISSION ON AGRICULTURAL RESEARCH

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Agriculture Division

Food and Agriculture Organization of the United Nations
Rome, Italy

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INTRODUCTION

The First Meeting of the European Contact Group on the Uses of Isotopes and Radiation in Agricultural Research was held, by courtesy of the Government of the Netherlands, at Wageningen, 10-14 December 1956. The meeting was attended by 31 representatives of 16 European member governments, and by observers from one non-European government, one non-member government, and eight international organizations, as listed in the following chapter.

The meeting was opened by Dr. R.A. Silow of the Agriculture Division of FAO on behalf of the Director-General. Dr. Silow thanked the Netherlands Government for its kind invitation to convene the meeting at Wageningen and for the generous facilities made available, and expressed appreciation of the personal interest shown in the meeting by His Excellency Dr. S.L. Mansholt, Minister of Agriculture, Fisheries and Food, and the many senior government, civic and university officers present.

Commending the recent decision of the Netherlands Government to establish in Wageningen a new Institute for the Application of Atomic Energy in Agriculture, Dr. Silow briefly surveyed the practical contributions of atomic energy to agriculture*. Although the availability of more plentiful supplies of reasonably priced electricity from nuclear reactors may be expected eventually to lower costs of production of farm products and raise living standards of rural peoples, this power aspect of atomic energy is likely to be the least important in the immediate future.

Aspects of greatest significance for agriculture at present are the radioactive isotopes and radiations that have become available in quantity as the result of the advent of atomic energy. Radioisotopes, used as highly refined research tools, are giving information on the fundamental biological principles involved in growing crops and livestock that could be obtained in no other way or only at much greater expense in terms of time and money. Radiations also have a wide range of applications of interest to the agriculturist, their mutation-inducing capacity being of value to the plant breeder in developing improved varieties of crop plants, whilst the possibilities of putting their lethal effects to good use in developing new methods of pasteurizing and sterilizing perishable foodstuffs are under investigation.

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* A more extensive survey entitled "The Uses of Atomic Energy in Food and Agriculture" presented by FAO to the United Nations Conference on the Peaceful Uses of Atomic Energy held in Geneva, August 1955, is available on request (in English, French or Spanish editions) from the Director, Agriculture Division, Food and Agriculture Organization of the United Nations, Rome, Italy.

In these ways radioisotopes and radiations are leading to the development of improved techniques and greater efficiency in the production, processing and utilization of food and other agricultural products.

Such potential economic contributions of atomic energy to agriculture, largely through research applications, could, it has been authoritatively stated, be of much the same order of magnitude as the more spectacular and obvious contributions of atomic energy to the generation of electric power.

The new techniques made possible through radioisotopes and radiations must, however be placed in their proper prospective. Whilst they will in due course come to be regarded as indispensable aids to the biological investigator, they must take their proper place amongst all the other modern equipment and procedures with which the research worker must be provided.

Furthermore, information gained with their help must be interpreted against a mature background of knowledge and experience gained through comprehensive and properly balanced programs of research across the whole field of agriculture. Lastly, those research programs must be supplemented by effective agricultural advisory services designed to bring the results of research to the farmer and translate them into practice without delay.

The European Contact Group on the Uses of Isotopes and Radiation in Agricultural Research has been established by FAO to provide a medium for the exchange of information between European countries on present and planned programs, with a view to identifying applications likely to be of greatest significance for European agriculture, and stimulating promising lines of research by facilitating contacts between investigators working on common problems and encouraging inter-country cooperation where appropriate. This will enable countries to pool their knowledge and experience for the common good, and make the most effective use of relatively limited financial resources, laboratory facilities and trained scientific manpower available for agricultural research in Europe.

His Excellency Dr. S.L. Mansholt, Minister of Agriculture, Fisheries and Food, welcomed participants on behalf of the Government of the Netherlands. Dr. Mansholt said that since there is a direct relationship between the level of the agricultural research of a country and the development of its agriculture, continuing improvements in agricultural development are dependent upon intensification of research and refinement of techniques.

Recognizing that the use of isotopes and radiation could open new vistas of investigation and new perspectives in agricultural research, the Netherlands Government had decided to establish at

Wageningen an Institute for the Application of Atomic Energy in Agriculture, as a center of research, instruction and information. It was hoped, however, that this would not remain a purely national institute, but would in due course develop into a European center for the application of atomic energy in agriculture and that it would stimulate international cooperation amongst scientists in this field.

There was a general awareness that in nuclear development and research countries must pool their resources, as evidenced on a world-wide basis by plans for the establishment of the International Atomic Energy Agency of the United Nations, and on a regional basis by discussions in Europe between OEEC countries and on the Euratom plan. These discussions and proposals were so far mainly concerned with power. This meeting was therefore of especial importance as it was particularly concerned with agriculture.

Dr. Silow announced that it had been hoped that Professor George de Hevesy, who had originated and done so much to stimulate the use of radioisotopes as tracers in biological research, would be present at the meeting, at the invitation of FAO. Professor Hevesy had, however, much to his regret, not found it possible to attend. On the proposal of Professor J. Moustgaard (Denmark), the Contact Group unanimously decided to send Professor Hevesy a telegram conveying their greetings and good wishes and expressing appreciation of his life-long contribution to this field of science.

This report is a summary of the proceedings of the meeting. Background documentation submitted by delegations is included in a supplement to this report.

PARTICIPATION IN THE MEETING

Delegations from European Member Countries

Austria

H. Lokscha, Min.Rat., Bundesministerium für Land- und Forstwirtschaft, Stubenring 1, Wien I

Belgium

A. Van den Hende, Analytical and Physical Chemistry Laboratory, Agricultural University, Coupure Links 233, Gand

G. Peeters, Veterinary College, University of Gand, Gand

A.A.J.R. Riga, Assistant, Government Station of Agricultural Chemistry, Gembloux

Denmark

V. Middelboe, Laboratory Superintendent, Physics Dept., Royal Danish Veterinary and Agricultural College, Copenhagen

J. Moustgaard, Head of Dept. of Physiology and Endocrinology, Royal Danish Veterinary and Agricultural College, Copenhagen

J. Sandfaer, Leader, Agricultural Research Activity of the Atomic Energy Commission, Christiansborg, Copenhagen

Finland

J.K. Miettinen, Lecturer, Biochemical Institute, Helsinki University, Kalevankatu 56 B, Helsinki

France

G. Barbier, Institut National de la Recherche Agronomique, Station Central d'Agronomie, Route de Saint-Cyr, Versailles

M. Roux, Chef du Group de Biologie Végétale, Centre d'Etudes Nucléaires, Saclay, S. et. O.

C. Thibault, Directeur, Station de Physiologie Animale, Jouy-en-Josas, (Seine et Oise)

Germany

J. Kuprianoff, Director, Federal Research Institute for Food Preservation, Karlsruhe, Kaiserstr. 12

F. Scheffer, Agrikulturchemisches und bodenkundiliches Institut, Universität Göttingen, Nikolausberger Weg 7, Göttingen

H. Sauer, Bundesministerium für Atomfragen, Luisenstr. 46, Bad Godesberg, Bonn

P. Schwarze, Leiter, Biochem.Lab., Max Planck Institut, Köln-Vogelsang

Ireland

D. Hoctor, Chief Inspector, Department of Agriculture, Dublin

Israel

J. Peleg, Director, Agricultural Research Station, Rehovoth, P.O. Box 15

Netherlands

A.C. Schuffelen, Director, Laboratory of Agricultural Chemistry, Agricultural University, Herenstraat 18, Wageningen

W.R. van Wijk, Director, Laboratory of Physics and Meteorology, Duivendaal, 2, Wageningen

E.C. Wassink, Director, Laboratory for Plant Physiological Research, Agricultural University, General Foulkesweg 72, Wageningen

Norway

Knut Mikaelsen, Associate Professor, Institute of Genetics and Plant Breeding, Agricultural College, Vollebekk

Portugal

J.M. Arriaga e Cunha, Estação Agronómica Nacional, Sacavem

J.J. Amaral Mendes, Veterinarian, Laboratório Central de Patologia Veterinária, Lisbon

Spain

E. Aranda Heridia, Director, Agricultural Mechanics Station, Instituto Nacional de Investigaciones Agronómicas, Avenida de Puerta de Hierro, Ciudad Universitaria, Madrid

Sweden

A. Gustafsson, Swedish Forest Research Institute, Experimentalfältet, Stockholm

Switzerland

R. Bach, Agrikulturchemisches Institut, E.T.H. Universitatstr.2, Zürich

A. Bolay, Station fédérale d'essais agricoles, Lausanne

United Kingdom

J.C. Boursnell, Agricultural Research Council, Unit of Reproductive Physiology and Biochemistry, Animal Research Station, Huntingdon Road, Cambridge

H. Seligman, Head, Isotopes Division, Atomic Energy Research Establishment, Harwell, Didcot, Berks

Yugoslavia

Z. Popović, Co-worker, Institute for Tobacco, Beograd

D. Stanković, Professor of Fruit Culture, University of Beograd, Sanje Zivanovíca 12/II, Belgrade

Observers from Other Member Countries

United States of America

Paul B. Pearson, Chief, Biology Branch, Division of Biology and Medicine, U.S. Atomic Energy Commission, Washington, D.C.

Observers from Non-Member Countries

USSR

V.M. Kletchkovsky, Professor of Agricultural Chemistry, USSR Academy of Agricultural Sciences, Tiuiriazev, Moskow 8

Observers from International Organizations

United Nations

M. Errera, Université Libre de Bruxelles, Bruxelles, Belgium

United Nations Educational, Scientific and Cultural Organization

W. Moller, Program Assistant, Department of Natural Sciences, UNESCO, 19 Av. Kléber, Paris, France

European Association for Animal Production

C. Thibault, Chief, National Zootechnical Research Center, Animal Physiology Department, Jouy-en-Josas (S. et O.), France

International Confederation of Technical Agriculturists

André Scoupe, Président adjoint, CITA, 129 Boulevard St. Germain, Paris, France

Organization for European Economic Cooperation

Einar Saeland, Consultant in Nuclear Energy, OEEC, 2 rue André Pascal, Paris XVIème, France

H. Itschner, Head of Division, Directorate for Agriculture and Food, OEEC, 2 rue André Pascal, Paris XVIème, France

European Confederation of Agriculture

G.J. Klompe, Gronjéstraat 11, Arnhem, The Netherlands

International Dairy Federation

H. Mulder, Laboratory for Dairy Science, Agricultural University, Lawickse Allee 1A, Wageningen

Institut International du Froid

T. van Hiele, Director, Institute for Storage and Processing of Fruit Products, Haagsteeg 6, Wageningen

FAO Staff and Consultants

R.A. Silow, Specialist in Applications of Atomic Energy, Agricultural Institutions and Services Branch, Agriculture Division, FAO, Rome

T.F. Peebles, Agricultural Officer, Agricultural Institutions and Services Branch, Agriculture Division, FAO, Rome

N.E. Holmes, Nutrition Division, FAO, Rome

J.C. Shaw, Consultant, Animal Production Branch, Agriculture Division, FAO, Rome; permanent address: Professor of Dairy Husbandry, College of Agriculture, University of Maryland, College Park, Md., USA

P.B. Collins, Information Officer, Information Division, FAO, Rome

Officers of the Meeting

Professor A.C. Schuffelen (Netherlands), having been designated Coordinator of the Contact Group by the Director-General of FAO with the approval of the Netherlands Government, served as Chairman of the Meeting.

By invitation of the Chairman, the following delegates occupied the chair during discussion of the following items:

Uses of Isotopes in Plant Research	: Dr. J. Peleg (Israel)
Uses of Isotopes in Animal Research	: Prof.J. Moustgaard (Denmark)
Uses of Radiation in Plant Breeding	: Prof. A. Gustafsson (Sweden)
Uses of Radiation in Food Preservation	: Prof. J. Kuprianoff (Germany

The following served as rapporteurs for the items indicated:

Uses of Isotopes in Soil Research	: Dr. G. Barbier (France)
Uses of Isotopes in Plant Research	: Prof. E.C. Wassink (Netherlands)
Uses of Isotopes in Animal Research	: Dr. J.C. Boursnell (U.K.)
Uses of Radiation in Food Preservation	: Mr. N.E. Holmes (FAO)

Dr. R.A. Silow (FAO) served as Technical Secretary.

ORIGIN AND RELATIONSHIPS OF THE CONTACT GROUP

The Technical Secretary described the origin and relationships of the Contact Group. Whilst representing in part a contribution by FAO, within its particular field of responsibility, to the general United Nations program for the promotion of the peaceful uses of atomic energy, the Contact Group in its present form owed its origin to an independent initiative of the Sub-Commission on Agricultural Research of the FAO European Commission on Agriculture.

The European Commission on Agriculture, established by FAO in 1949, is composed of senior government representatives concerned with the formulation and administration of agricultural policy and programs in their countries. The Commission acts as a two-way channel of communication between FAO and its member Government in Europe, in one direction giving consideration to the FAO program of work and the ways in which it might be developed to provide the maximum benefit to member governments in the region, and in the other direction giving consideration, in the light of the pooled knowledge and experience of members of the Commission, to the ways in which individual country programs might through international cooperation be further developed for the benefit of their agriculture.

Established by FAO under the aegis of the Commission is a Sub-Commission on Agricultural Research, composed of senior administrative officers of European governments responsible for the organization and administration of agricultural research in their countries. The purpose of the Sub-Commission is to consider, through the exchange of information and pooling of experience, ways in which the organization of agricultural research could be improved in member countries in Europe. It has also directed attention to certain fields of agricultural research in which progress might be accelerated through joint discussion between countries and, if need be, through the encouragement of cooperative investigations.

At its Second Meeting, held in The Hague in August 1955, the Sub-Commission directed attention to six such fields in which more intensive cooperation might be established, amongst them being included "The Applications of Atomic Energy in Agriculture". Subsequently, in response to an enquiry from FAO, member governments gave highest priority to the establishment of a cooperative project in this field.

The Director-General of FAO thereupon expressed his readiness to establish a liaison or "Contact Group" in this field, and invited member governments to nominate permanent representatives to it. Those representatives would act as the central liaison officer within their respective countries for discussion and correspondence. They were to be either research administrators or specialists, but if the latter they were to be nominated not so much in their specialist capacity as on the basis of their familiarity with the whole range of work involving the use of isotopes or radiation in progress in their countries. Government nominations received by FAO up to December 1956 are listed in the Supplement.

For this present initial meeting of the Contact Group it was indicated to governments that, in view of the extremely wide field to be considered, representation need not be restricted to a single individual.

COUNTRY PROGRAMS AND PLANS

The Contact Group reviewed the present status of country programs and plans involving the use of isotopes and radiations in agricultural research*. Relevant documentation submitted by delegations and FAO is presented in the Supplement.

Although the tracer technique was introduced in Denmark in 1923 by Prof. George de Hevesy, it was only after the Second World War that any substantial expansion in the use of isotopes began in Europe, that is to say some 5 to 10 years later than in the United States of America.

In many countries this leeway seems to have been made up quickly, and the Contact Group considered that the presence of eminent American investigators concerned with the use of isotopes in research at its first meeting would undoubtedly make an important contribution to the development of isotope usage in agricultural research in Europe.

Discussions revealed wide differences in extent of usage in various countries within the region, ranging from some in which isotopes are available at almost all institutions and used as a routine in all appropriate investigations, to many in which usage is limited or even completely non-existent as yet. It was evident that in the region as a whole their usage has advanced furthest in animal research, doubtless on account of their particular value in elucidating the more highly complex dynamic biological processes.

The positive results that have already been obtained justify the enthusiasm that investigators have shown for the new research techniques made possible by isotopes, and several European countries that have not yet used them in agricultural research are taking measures to do so in the near future (for example, Austria, Ireland, Israel, Spain and Switzerland).

The availability of isotope techniques and the re-investigation of basic concepts which they make possible are likely substantially to modify the orientation of research programs.

Whilst radio-isotopes are not expensive to use and the techniques require only a relatively short period of training, so that their use now appears to be within the reach of all laboratories, the use of

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* In view of the desirability of keeping closely related topics involving common principles together, for the purpose of the work of the Contact Group the term isotopes shall be considered to include stable as well as radioactive isotopes and the term radiations to include ionizing and non-ionizing radiations derived from electrical machines as well as from radioactive sources.

stable isotopes involves greater difficulties and is hardly at all developed in Europe. This is a serious deficiency. Among the various fertilizing elements there is no doubt that the greatest progress could be made with reference to nitrogen, both as regards our knowledge of its behaviour in the soil and the part it plays in increasing crop yields. As nitrogen has no usable radio-active isotope, the use of the stable isotope ^{15}N should be encouraged. For this purpose a mass spectrometer is required, an instrument that only a few European institutes possess. This situation should be rectified as so n as possible. Consideration should also be given by the Contact Group at a future meeting to the types of instruments best adapted for various purposes and the conditions under which poorly-equipped laboratories could have determinations carried out for them in other laboratories.

The Contact Group considered that it is not necessary at this time to draw up special plans for co-operative research utilizing isotopes. Isotope techniques are invaluable and irreplaceble for many investigations and should essentially be regarded as supplementary working tools which should be available whenever needed.

Discussions on the use of isotopes and radiation in agricultural research were organized under five subject-matter headings as follows:

1. Uses of isotopes in soil science
2. Uses of isotopes in plant science
3. Uses of isotopes in animal science
4. Uses of radiation in plant breeding
5. Uses of radiation in food preservation and processing

Uses of Isotopes in Soil Science

In the field of soil science and crop nutrition the isotope technique has been applied notably in the following categories of investigations:

1. Investigations on the validity of the isotope technique.
2. Quantitive determination of the active fraction of various soil ions by the isotope dilution technique.
3. The respective roles of soil and added fertilizers in crop nutrition.
4. Vertical migration of various ions in the soil.
5. Phenomena concerning the contact area between roots and soil.
6. Evolution of organic matter in the soil.

1. Validity of the isotope technique. (studies reported by Belgium and Denmark)*

In this connection there are two main points to consider. Firstly, as radiations emitted by radio-elements can disturb plant functions, it is necessary to guard against overdoses. Secondly, the isotopic varieties of various ions or molecules may not have absolutely identical physical or chemical properties. However, it does not appear that mistakes due to these factors have had any serious consequences.

2. Determination of the active fraction of various soil ions by the isotope dilution technique (^{32}P, ^{45}Ca, ^{42}K, ^{59}Fe).

An important part of the soil research carried out with the help of isotopes is inspired by the technique of isotope dilution aiming to determine the amount of diffusible ions of a certain type, i.e. of those "that spend part of their time in a free solution" (synonyms - isotopically interchangeable; mobile; active; "surface").

This method has been brought to perfection through studies carried out almost simultaneously in Finland, Denmark, the United Kingdom, France, Germany, and without doubt in other European countries, and also outside Europe.

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* In this Summary Report country names are quoted as examples of countries where certain investigations have been conducted or are in progress, and the listing is not necessarily complete. More complete information available will be found in the country statements in the Supplement to this report.

Comparisons between results obtained through isotopic dilution in the presence or absence of plants (Finland and France) suggest that at a given moment, isotopically dilutable ions (especially PO_4) can be identified with available ions. Since this method, though solidly based in its principle, is not exempt from criticism in its applications, it would be useful to discuss it thoroughly at a future international meeting on soil science.

3. The respective roles of soil and fertilizers in crop nutrition.

When labelled fertilizers are localized in the soil, the isotopic and chemical analysis of the plant makes possible determination of the quantity of an element taken from the fertilized and unfertilized zones. It is also possible to compare the efficiency of various fertilizers, to specify the mechanism of their action (research carried out in many countries), to study the most efficient means of their incorporation in the root system (of fruit trees especially) or to investigate the root system itself (United Kingdom).

4. Vertical migration of the various ions in the soil. (Denmark and Yugoslavia).

These investigations may be very important in forecasting the limit of accumulation of long-lived radio-elements (fission products).

5. Phenomena concerning the zone of contact between roots and soil.

Studies using isotopes, started and carried out in the United States, on exchange of ions between roots and medium and on the dissolving action of roots, make possible investigations in this field that are of special significance in agronomy.

6. Evolution of organic matter in the soil. Studies utilizing ^{14}C, ^{15}N, ^{32}P, ^{35}S (United Kingdom and Germany).

To this very incomplete list must be added general applications, such as measuring the moisture content in the soil by neutron-scatter (United Kingdom).

Besides its extraordinary sensitiveness in the analytic field, the isotope technique has various specific advantages for soil science. For instance this method makes it possible to observe thermal movement of ions without disturbing the natural equilibrium.

From the country statements it was evident that the use of the isotope technique has expanded rapidly in very many European countries. It has already greatly contributed to knowledge of soil fertility and crop nutrition, notably by giving precision to rather vague conceptions, such as those concerning availability, and by facilitating the general re-orientation of research methods it has made them more fruitful.

There is reason to believe that the isotope technique will greatly contribute in the future to advancement of our knowledge in little explored and highly complicated fields, such as the biochemical evolution of organic matter in the soil, by use of refined methods such as "co-chromatography " (a French term signifying a combination of paper chromatography and radio-autography) which have already proved valuable in physiological studies.

Uses of Isotopes in Plant Science.

Austria

Studies are in progress on the influence of radiation on plant growth; on absorption of phosphorus through leaf surfaces; and on uptake of minor elements.

Belgium

In studies up to the present a localization method for ^{32}P and ^{45}Ca in slices of plant tissue by auto-radiography has been worked out. In apple trees it was found that translocation of ^{32}P is very slow. No translocation of ^{32}P from the stock to the graft occurs within 24 hours. An extensive program of research is in progress or has been planned, including studies on the absorption of ^{32}P, ^{45}Ca, ^{35}S and minor elements; the study of systemic insecticides in the insect and in the plant; studies using ^{14}C in photosynthesis; and the synthesis of plant hormones.

Denmark

Interesting observations have been made on the effect of fungicidal sprays on photosynthesis of apple leaves; the 6th and 7th leaf from the tip proved most useful for the measurement. $^{14}CO_2$ assimilation has been studied to determine whether the rate of photosynthesis differs in various individual plants of the same species. ^{24}Na has been used for studying the rate of ascent of sap in trees. The rates found were higher than those established by classical methods.

Finland

Diiodothyrosine was identified in lettuce plants after uptake of ^{131}I. In general it was found that intact plants take up elements better than cut parts. In peas the Ca content was found to be especially high in the nodule. Furthermore, it was found that Ca is evenly distributed through the plants, but on seed ripening it strongly accumulates in the pericarp, not in the seeds, which, consequently, require Ca to be supplied during the first 10 days of seedling growth.

France

The influence of the plant roots on the availability of phosphate in the soil has been especially studied. Among other subjects may be mentioned the assimilation of phosphate by isolated chloroplasts, the synthesis of nucleic acids, and studies on arginine synthesis and on oxydative phosphorylation in pea mitochondria. In addition it has been reported that plants under a filter consisting of a chlorophyll solution absorb CO_2 and form amino-acids rather than sugars or starch, whilst the latter were synthesized under a filter consisting of a carotene solution. Products formed were traced by the use of $^{14}CO_2$. Sulphur metabolism of tobacco leaves is also being studied, and the acid metabolism of Crassulaceae.

Germany

Metabolic studies are being made with radio-active P, C, S, Na and Co.

Netherlands

Some work with ^{14}C is being carried out, mainly in the field of photosynthesis. In one instance (not listed in the documentation) a mass spectrometer has been used for $^{14}CO_2$ analysis. The uptake, transport, and distribution of sodium by plants has been studied, using ^{22}Na. ^{32}P is being used for studies on phosphate metabolism in connection with photosynthesis. The path of phosphate during the early phases of an illumination period is being studied by a combination of paper chromatography and radio-autography. The effects of CO_2 and PO_4 supply are being studied, as well as movement of P to and from leaves in light and darkness. A survey has been prepared (now in press) on the accumulation of elements in plants to provide information on the possibility of accumulation in plants and by way of them in animals and man of radio-active elements in wastes from nuclear reactors. Figures are very different for various elements, plants and external conditions (e.g. concentration

of the element); aquatic plants and halophytes especially tend to accumulate considerable amounts of some elements but some quite extensive accumulations in other cases have been reported in the literature.

Norway

Work is in progress on the uptake of ^{32}P by roses grafted on various root stocks. Investigations with young spruce trees have shown that nutrient uptake is dependent on the pretreatment of the soil. The isotope ^{86}Rb was used in this work. A highly sensitive method has been worked out for analysis of Co in plant materials, using neutron activation (see documentation).

Portugal

Sap movement in trees is being studied, using ^{32}P and cutting the trees after different intervals. "Straight head" (sterility) of rice is considered to be due to copper deficiency, which element is probably fixed to organic matter under anaerobic conditions. This is being studied by the use of ^{64}Cu.

Sweden

Among the many investigations using isotopes in agriculture and its basic sciences in progress in this country may be mentioned studies on sugar metabolism and amino acid metabolism, incorporation of ^{14}C into cyclic structures, studies on the micorrhiza problem, interconnections between roots of various individual trees in a closed stand, the relation between nodule bacteria and leguminosae, and the distribution of nutrient elements in fruit trees. Studies were also reported on the effect of auxin on nutrient intake, and on the influence of differences in the root system between a barley mutant and its mother strain on phosphate metabolism.

United Kingdom

A considerable amount of work is also going on in this country, including studies using ^{32}P and ^{86}Rb on movement of nutrients in the plant in relation to light intensity and transpiration rate; an analysis of factors governing uptake of weak organic acids by Lemna minor, using ^{14}C; studies in nucleic acid metabolism, using ^{32}P and ^{14}C; the control of tobacco mosaic virus by ^{35}S thiouracil; studies on carbohydrate metabolism, using ^{14}C, including the effect of nitrogen nutrition; study of the distribution of iron and molybdenum in protein fractions of Azotobacter, using ^{59}Fe and ^{90}Mo; and studies using ^{32}P and ^{15}N on foliar absorption of nutrients.

Yugoslavia

Studies were reported on phosphorus metabolism in fruit trees, and on uptake of nutrients by a species of Orobanche on tobacco. The influence of X and gamma radiation on the germination and growth of many cultivated plants is also being investigated. In seedlings of grasses and cereals the stage of development was found important for sensitivity towards these radiations. Artificial polyploids appeared to be more resistant than diploid forms

The observer from the United States of America reported that many similar investigations are in progress in that country, including extensive work on the role of carbon in photosynthesis and the participating enzymes, using mainly ^{14}C and recently also ^{17}O; studies on absorption of substances by leaves, e.g. urea; research on weedkillers; study of the uptake of Ca and Sr by leaves, it having been found that Sr is taken up only to a slight extent, which is of significance in relation to environmental contamination; and study of the uptake of elements by algae and plankton in the Columbia river.

In discussion, the delegate of Norway enquired from the delegate of Yugoslavia whether any stimulating effect on growth of low doses of X or gamma radiation had been observed. He replied that effects observed depended on the stage of development (in wheat). No proposal for practical use could yet be made.

The above reports indicate that so far as the represented countries are concerned the largest amount of work with radio-active isotopes in plant science up to now is in progress in the United Kingdom and Sweden. Smaller programs are in operation in various other countries, whilst some are only now establishing their programs. A great variety of subjects has been or will be studied. The isotopes most widely used are ^{32}P and ^{14}C. Interesting applications have been made of ^{15}N, ^{22}Na, ^{35}S, ^{60}Co, ^{64}Cu, ^{86}Rb, ^{90}Mo, ^{131}I and some others.

Uses of Isotopes in Animal Science.

Delegates presented a considerable amount of material which stimulated a great deal of mutual interest and discussion. The interest shown by delegates arose firstly because many more had a personal interest in this subject, and secondly because in many countries isotopes were applied earlier to animal work than to any other field of agricultural research. The subjects dealt with fell approximately into four categories:

1. Intermediary metabolism
2. Mineral metabolism
3. Endocrinology
4. Reproduction

1. Intermediary Metabolism

The main interest centered in the biochemical processes occurring in the rumen of the sheep and in the mammary gland of the cow. Research on these topics, in which a number of different isotopes or isotopically tagged compounds were used, is being carried out in several countries. These researches are being actively pursued in Belgium, Denmark, Finland and the United Kingdom.

2. Mineral Metabolism

Interest in the fate of phosphorus and calcium in the animal body continues to occupy the attention of many investigators. Special aspects of this work are in progress in Austria, Denmark and Germany. Micro-mineral studies using radioactive cobalt and copper are being conducted in the Netherlands and in the United Kingdom.

3. Endocrinology

Studies on thyroid function lend themselves admirably to the use of ^{131}I and particular aspects of this work are being studied in Austria, Denmark, the Netherlands and the United Kingdom. The delegate from Yugoslavia also reported endocrine work with isotopes in his country.

4. Reproduction

The great interest in studies on reproduction in animals, stimulated in recent years by the successful and widespread application of artificial insemination, is providing attractive problems in which isotopes may be used. This work is actively going on in France and the United Kingdom.

5. Miscellaneous

The action and fate of an antiseptic drug used in a lung infection is being studied in Belgium with a radio-isotope. Red cells marked with ^{32}P, ^{51}Cr or ^{59}Fe are being used in haematological studies in Denmark, Germany and the United Kingdom. Entomological studies with wheat-bugs (Dolycoris baccarum and Lygus rugulipennis) marked with ^{14}C are proceeding in Finland. ^{90}Sr accumulation studies are being undertaken in Sweden.

The problems mentioned above are representative of the great interest which is being shown in all the countries represented. Already a number of countries which have not yet used isotopes in animal science in the agricultural field have laid plans for doing so. It is quite certain that the mutual interest shown will have profound affects in stimulating the use of isotopes as a tool in animal research.

The Use of Radiation in Plant Breeding.

The value of radiations in plant breeding arises from the fact that the genetic materials - the genes and chromosomes - are highly sensitive to ionizing radiations and other short-wave radiations such as ultraviolet light. These radiations induce hereditary changes or mutations, which are an essential basis for the improvement of crops. Although mutations may be induced in both animals and plants, radiation breeding has so far mainly been applied in crop improvement.

Following an introductory survey of the use of radiations in genetical studies and in plant breeding by the Acting Chairman of the session, Professor Gustafsson (Sweden), delegations reported on activities and accomplishments in their countries.

In Austria mildew resistance has been obtained in barley following the use of ionizing radiation.

In Belgium disease-resistant and short-strawed and stiff-strawed types have been obtained in cereals, and an extensive program with a number of cultivated plants is now in progress.

In Denmark no work has so far been carried out but a program has been planned and will commence in 1957.

In France the most extensive work has been carried out with tomatoes.

In Germany research involving the use of radiations has been in progress for many years and practical results have been achieved, including mildew resistance in barley and useful mutations in the black currant.

In Ireland work is in progress in wheat and barley.

In the Netherlands some work has been carried out with horticultural plants.

In Norway extensive work has been in progress for several years, particularly in barley, and promising types obtained, especially with regard to earliness, straw stiffness and yielding ability. Work has recently been extended to include vegetables, fruits, and ornamental and medicinal plants.

In Portugal fundamental studies on the genetic effects of radiation were carried out some years ago.

Sweden is the pioneering country in the use of radiation in crop breeding, such activities tracing back to around 1930. At present a number of investigators are engaged in fundamental and applied research on radiation-induced mutations.

In Sweden two new varieties are already on the market which were selected from irradiated material. One is a pea variety from Weibullsholm and the other a white mustard variety from Svalöf. Barley has been the object most intensively studied and a number of valuable biotypes have been produced. In addition to types with stiff straw and other valuable characteristics, increased yielding capacity has been obtained in several mutants. The present program includes nearly all agricultural plants cultivated in Sweden.

In the United Kingdom work is in progress at Cambridge with wheat and barley. Short-strawed types have been obtained from this material which appear to be of agronomic value. Mutations have also been obtained in sweet cherries. At Aberystwyth radiation has been used to break down the barrier to crossing between such genera of grasses as Lolium and Festuca.

Important work in progress in the United States of America was also reported.

In European countries X-rays have been the main type of radiation employed, but in countries with reactors or cyclotrons neutrons have also been used. Outdoor ^{60}Ca installations have been in operation for some years in Norway, Sweden and the United Kingdom (Wales). Several other countries are planning to install gamma fields.

Ultra-violet light is also an effective means of inducing mutations and its effects differ from those of ionizing radiations. Several chemical compounds also have mutagenic effects. There is as yet no evidence that any particular type of radiation is more effective than others in inducing useful mutations and further investigations with all types of radiation and with other mutagenic agents should be carried out. Apart from the more immediate practical contributions to crop production that may be expected, such work will advance fundamental knowledge in genetics, which is an essential foundation for continuing progress in crop and animal breeding. In addition investigations of this nature will provide an additional source of knowledge in radiobiology of great importance in connection with general atomic energy developments.

The Contact Group is convinced that radiation is an important tool in plant breeding and that its use in this connection should be encouraged. In this connection it directed attention to the need that cytogenetic studies should be closely associated with practical radiation plant breeding programs.

The representative of the United Kingdom (Dr. Seligman) indicated that it would be possible to make available for the use of investigators in other European countries some space in the gamma field at the Wantage Radiation Laboratory near Harwell.

The Technical Secretary reported that, as a contribution to international cooperation, the Brookhaven National Laboratory in the United States had offered to make available for the use of other countries the laboratory's neutron irradiation facilities for seed material or cuttings. Investigators in European countries wishing to avail themselves of this generous offer should, before sending material, write to the officer in charge of the project, Dr. Seymour Shapiro, Biology Department, Brookhaven National Laboratory, Upton, Long Island, New York, U.S.A., for instructions on procedures to be followed in the preparation and mailing of the material. It is particularly important that these instructions be followed in all details in order to satisfy quarantine regulations in the United States. Arrangements to satisfy the quarantine requirements of his own country on the return of the irradiated material should be made by the sender before despatching his material.

The Use of Radiation in Food Preservation and Processing.

The Contact Group discussed at some length the reports which several countries had presented on the progress of research in the irradiation of foods.

General

The preservation of food by the use of ionizing radiations is of special interest because some of these radiations have considerable penetrating powers and the quantity of energy absorbed by foods during radiation is low and thus the rise in temperature of the food is small.

The effects produced in food by irradiation are very complex and are determined by the nature of the food itself, the conditions during irradiation and the level of radiation. These effects may be caused by physical, chemical, biochemical or biological actions of the radiations. Ionization may be quoted as an example of the effects of physical action, the destruction of enzymes as an example of biochemical action, and the destruction of insects and micro-organisms as an example of the biological action of radiations.

Much of the research on the irradiation of foods has been carried out in the United States and there are many published papers describing this work.*

* A report on a "Conference on Biological, Physical and Industrial Aspects of Potato Irradiation" made available by courtesy of the Brookhaven National Laboratory in the United States of America was distributed to participants.

Nevertheless a considerable amount of work has been carried out in the United Kingdom on the irradiation of several kinds of meat, fish, potatoes, egg-products and infested grain.

Work on the subject was commenced in Germany in 1950 and a long term program of research is now in hand. In Norway, during the past few years, work has been done on the suppression of sprouting in potatoes and root crops and on prolongation of the storage life of bananas through the use of radiation. In the Netherlands and Sweden work has also been done on the suppression of sprouting in potatoes by irradiation, and similar work has also been carried out in France. Various other countries have expressed keen interest in such work and hope to develop their own programs.

Most of the work done on this subject has been concerned with:

a. the preserving effects of radiation on different foods at different dosage rates;

b. the changes brought about in the colour, odour, flavour, texture and transparency of the irradiated foods;

c. the safety of the irradiated foods as measured by extensive feeding tests with animals, and so far to a much lesser extent with human volunteers.

Types of radiation.

The types of radiation used or envisaged for such work are:

a. radio-active sources which could be the reactor itself, or some part of its cooling medium, fuel rods, separated fission products, processed isotopes or radio-active gases;

b. electrical machines producing high energy electrons (cathode rays) or electromagnetic radiation (x-rays).

The general level of radiation varies from 2 x 10^6 rads[x] for complete sterilization to 5 x 10^3 rads for the suppression of sprouting in potatoes.

There is no known difference in the action of these different types of radiation but the penetration of the rays depends on the specific weight of the food being irradiated and the energy of the radiation.

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x) One rad is equivalent to the dissipation of 100 ergs per gram of tissue.

Generally it can be stated that X-rays may be used for the irradiation of surfaces but the efficiency of the process is low. Gamma rays produced by radio-active materials such as Cobalt-60 or by fission products may be used for the irradiation of foods up to a thickness of 100 to 150 millimeters, while electron rays produced by machines with a range up to 15 MeV are suitable for use for foods with a thickness up to 70 millimeters.

Much attention has been given to the use of mixed fission products for the irradiation of foods. In this connection the most serious problem is that of induced radio-activity in the trace metals in foods if the source of irradiation used were to contain neutrons. If treatment of mixed fission products is undertaken to concentrate or purify the products it is a relatively simple matter to extend the process and produce pure fission products. For research purposes these pure fission products such as Caesium-137 are more useful since, by using them, it is much easier to measure the distribution of radiation within the food being irradiated.

Changes produced in food by irradiation.

The irradiation of foods produces many chemical reactions within the foods. So far it has not been possible to identify the substances which are produced in very small quantities by these reactions.

The most important result of any such changes would be the possible presence in the irradiated foods of substances toxic to man.

Fairly extensive tests have been conducted by feeding animals on irradiated foods but, so far, these tests have not revealed any toxic substances in these foods.

Many authorities consider that research on the whole problem of food irradiation should be continued and intensified since much more work has still to be done and many more feeding tests will have to be undertaken before a final decision can be reached regarding the safety to man of irradiated foods.

Undesirable changes in the colour, texture, odour and flavour of irradiated foods have frequently been reported. Depending on the level of radiation used, the extent of these undesirable changes varies with the nature of the food and the conditions under which it is irradiated. The changes in odour and flavour of the irradiated foods appear to be related fairly closely to the level of irradiation used.

Summary of present views.

Work on the irradiation of foods is still in the developmental stage so that, at present, it is not possible to do more than make a general statement about experimental observations and trends of opinion. These are as follows:

a. Lower dosage rates may be preferred because the health risks are decreased, the extent of undesirable changes in the irradiated food is less, and the cost of the treatment is lower.

b. Some foods such as milk and milk products appear to be more susceptible than are other foods (such as pork and poultry) to undesirable changes produced as the result of irradiation.

c. The destruction of insects in stored products (grain, dried fruits, etc.), the suppression of sprouting in potatoes and root crops and the treatment of some fresh meats would appear to be the most promising forms of application of ionizing radiations to foods.

The possibility of extending the storage life of bananas by irradiating them prior to the ripening treatments might be of importance in a country like Norway where the bananas, after ripening, have often to be transported over long distances.

d. Chemical and microbiological effects produced at high dosage rates are not considered necessarily to be the same as those produced at very low dosage rates.

e. The spoilage in foods after irradiation may not necessarily be the same as that in non-irradiated foods.

f. The combination of irradiation with other methods of preservation (and particularly with refrigeration) would seem to be a promising development.

g. The cost of irradiation might well be an important factor in determining the rate of development of this form of food processing.

h. Since it has been proved that each of the older methods of food preservation has advantages for particular kinds of foods and also for particular communities, it is unlikely that irradiation will replace the older systems of preservation.

In concluding its discussion the meeting agreed that the use of ionizing radiations for the preservation of foods opens up a vast field of research. Many problems remain to be solved and much more information is needed.

Research work in this field is difficult to conduct and, on account of the complexity of the problems involved, it requires the services of highly-trained scientists skilled in various disciplines.

Great care must be exercised to avoid any forseeable risks during the processing of the foods and in their final use. It is also necessary to avoid misleading the public by overrating the possibilities of this form of food preservation, or alarming the public by incautious statements about its lack of safety. Active and well-considered programs of research conducted by institutions with a high reputation are the best safeguards against such dangers.

To embark on work on the irradiation of foods without the necessary facilities and trained staff would be unwise and for this reason careful attention should be given to the possibility of international cooperation in this important and difficult field of research and investigation.

THE SIGNIFICANCE OF ISOTOPES AND RADIATION FOR AGRICULTURAL RESEARCH AND DEVELOPMENT IN EUROPE

Very substantial advances have already been made in agriculture through the use of isotopes and radiation, just as they have in medicine and industry. This is particularly true of the United States of America, but, as the discussions of the Contact Group have indicated, it is also true, though to a lesser extent, of some European countries. The Contact Group is convinced that even greater advances can be made in all European countries through a wider application of isotopes and radiation in their agricultural research programs.

On the basis of discussions during the presentation of country programs, the Contact Group summarized the more significant potentialities of isotopes and radiation for agriculture in Europe at this present time in the following terms.

Soil Science.

In the field of soil science a great deal of new and important information is already being gathered by using the isotope technic as a research tool. The use of ^{32}P has given much new information on the behaviour of soils, fertilizers and plants in respect to the phosphate-status of the soil and the availability of different forms of phospate to various crops. In this field additional research is needed on the problem of the isotopic exchange between added phosphates and soil phosphates.

There is urgent need for a deeper understanding of the behaviour of organic matter in the soil, especially the breakdown and synthesis of humic compounds, and this could best be gained by using isotopes of carbon and nitrogen.

The behaviour of nitrogen in the soil also requires further investigation. Extremely large quantities of nitrogen fertilizers are used annually but a large part of the added nitrogen is not taken up by the plants. The ways in which this nitrogen is lost are not yet understood. The use of the stable isotope ^{15}N will be very helpful in solving this problem. For this work more institutions will need to be provided with a mass spectrometer.

Plant Science.

In the field of plant science the use of isotopes has made invaluable contributions to knowledge of the basic mechanisms involved in plant growth. In particular, research in photosynthesis, the only means of capturing energy from the sun, has received much impetus through the use of isotope technics, with the result that the entire process is now much better understood and a firm foundation has been laid for further advances in this important field of investigation. The uptake and distribution of ions and other substances by plants have also been studied with isotope technics with great success, and the information on the physiology of the living plant thus obtained is contributing to a better knowledge of factors affecting crop production, whilst the use of isotopes in studies with insecticides, fungicides and herbicides is leading to more effective methods of reducing crop losses.

Animal Science.

In animal science isotopes are being used with such marked success in so many fields of investigation that they may now be regarded as an essential tool in much modern research. Particularly important advances are being made in the fields of intermediary metabolism and mineral metabolism. Studies of the biochemical processes in the rumen of the sheep and on lactation in the cow will soon bring practical benefits to agriculture. Information acquired through the use of ^{131}I in studies of thyroid function are also very worthwhile, as well as the results in connection with artificial insemination. Isotope techniques also hold promise of valuable contributions in veterinary medicine.

Plant Breeding.

In view of the valuable potential contributions of radiation-induced mutations to food and agricultural production, the use of radiation in national crop breeding programs should be encouraged. Mutation-induction by radiations is in fact one of many modern techniques essential to the fully equipped plant breeder. However, it is important that in countries with limited resources developments of this nature should not be at the expense of finance, personnel and facilities for the basic essentials needed for effective plant breeding programs and the production and distribution of improved seed.

Food Preservation and Processing.

Whilst the use of radiation in food preservation and processing undoubtedly offers attractive possibilities, particularly in association with more conventional methods, there are many highly complex problems to be solved before this will become a practical commercial proposition in Europe.

Nevertheless, it is important that practical experience of the techniques and problems involved should be acquired by some at least of those countries in Europe that can afford the substantial investment in research that will be entailed.

Since little precise information exists about the nature of the changes produced in food by irradiation, in any programs of research on the irradiation of food high priority should be given to feeding tests and any other techniques which might provide critical information on this highly important subject.

THE NATURE OF THE FINANCIAL PROVISION REQUIRED FOR RESEARCH PROGRAMS INVOLVING THE USE OF ISOTOPES AND RADIATION

In considering how progress might be accelerated, it became evident that quite different levels of financial support will be required for the three distinct categories of usage of isotopes and radiation in agricultural research.

So far as research involving the use of the so-called "isotope techniques" in soil fertility and in crop and livestock production are concerned, isotopes and the associated equipment needed are relatively inexpensive, and training in their use can be acquired in a relatively short time. These are techniques that should be available for use in all investigations where they are appropriate. Since the funds needed will not be unduly large, it is believed that governments will experience no great difficulty in giving work of this nature the necessary financial support.

The use of radiation in plant breeding requires somewhat more substantial financial support, but nevertheless the equipment needed is not very expensive and the additional expenditure will be small in relation to the total costs of a long-term breeding program. Whilst it is highly desirable that any plant breeding program involving the use of radiation-induced mutations should have its own radiation sources, international irradiation facilities that are available could be used at least in the early stages of such a program.

Research on food preservation by irradiation presents considerations of a totally different magnitude. Such research requires a very high degree of training of the several different categories of investigator concerned, and the cost of the necessary equipment and the maintenance of the laboratories will be very high. The size and cost of the radiation source itself, and the hazards in its use, must also be taken into consideration. In food preservation research as such the quantities of food involved are usually small and the radiation source need not be large. However, feeding trials are an essential part of investigations of this kind and when such trials are to be undertaken larger quantities of food and correspondingly larger sources of radiation will be involved. For the successful development and continuation of such investigations, very substantial expenditure is involved. The Contact Group therefore reached the conclusion that this is a subject in which international cooperation is highly desirable.

INDEX OF AGRICULTURAL RESEARCH INSTITUTES USING ISOTOPES AND RADIATION

The Contact Group discussed the desirability of assembling a list of agricultural research institutes using isotopes and radiation. A number of suggestions was made regarding the scope of this list and particularly whether it should include all institutes using isotopes and radiation, such as medical institutions and industrial institutions, or whether it should be restricted to agricultural institutions. The Group agreed that the task of assembling a complete list would be too great and that only agricultural institutes where large scale work was being carried out or where it was planned should be included.

A considerable amount of information was submitted by delegates concerning the institutions using isotopes and radiation at the present time. This material is incomplete but it was agreed it should be included in the supplement to this report.

It was reported that the preparation by FAO of a European Index of Agricultural Research Institutes is virtually complete. The suggestion was made and endorsed by the Group that this index should be circulated to members as soon as it is available with the request they indicate those institutions using or planning to use isotopes or radiation in their research programs.

The Group suggested that all this material be assembled by FAO as soon as possible into a separate list for the use of the research workers particularly concerned with the use of isotopes and radiation.

TRAINING FACILITIES AVAILABLE AND TRAINING PROGRAMS IN PROGRESS

The Group heard statements on the scope of training facilities for workers using isotopes or radiation in their research programs. There is a wide variation in the development of training facilities in Europe, although some countries such as France, the United Kingdom and the Union of Soviet Socialist Republics, have very substantial training programs. In some countries where no special facilities exist training is carried out in connection with regular university training. Training facilities are being expanded in response to the steadily growing demand for skilled workers in this field and in a number of cases special courses are being organized.

Special mention was made of the contributions of the United States of America and the United Kingdom to the training of European scientists in the use of isotopes and radiation. The United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority have been generous in making their facilities available. It was the hope of the Group that this would continue. More limited facilities in France have also been made available to workers from other countries.

The Contact Group was convinced that at this stage no special facilities are necessary for training in the use of isotopes and radiation with particular reference to agricultural research. Experience has shown that training in the use of isotopes and radiation need not be specialized for agriculture but that standard courses for all workers who find it necessary to use those tools suffice for agricultural scientists as well.

The work of O.E.E.C. in strengthening training facilities in Universities through the assistance of the European Productivity Agency was mentioned.

The group concluded its discussion by stressing the present need that increased opportunity be given to European agricultural research workers to obtain training in the use of isotopes and radiation.

THE DESIGN AND EQUIPMENT OF AN ISOTOPES LABORATORY FOR AGRICULTURAL RESEARCH

The Contact Group discussed some of the problems in connection with the design and equipment of an isotopes laboratory for agricultural research. In view of the wide interest in these problems and the

variation in costs of laboratories it was suggested that an index of recent material published could very usefully be prepared and circulated to the Group.

Attention is directed to the following publications on the design and equipment of laboratories - Technical Secretary.

- "Design of Laboratories for Safe Use of Radioisotopes" by D.R. Ward.

- "A Radioisotope Distribution Laboratory" by Paul C. Abersold and Lester R. Rogers.

- "Facilities and Equipment for Isotopes Program" by G.W. Morgan.

The above three reprints can be obtained from the Isotopes Division, U.S. Atomic Energy Commission, Oak Ridge, Tennessee, U.S.A.

- "Instrumentation for an Agricultural Radioisotope Laboratory" by C.S. Simons.

- "Radioisotope Laboratories for Animal and Agricultural Research" by G.G. Manov.

The above two articles will be found in "The Role of Atomic Energy in Agricultural Research", Proceedings of the 4th Annual Oak Ridge Summer Symposium, August 1952 - for sale by the Superindendent of Documents, U.S. Government Printing Office, Washington, 25, D.C., U.S.A., price $2.25.

- "Radioisotopes in Biology and Agriculture" by C.L. Comar - published by Mc Graw Hill Book Co., London and New York (481 pp.) - Chapter on "Facilities and Handling of Radioisotopes with Animals and Plants".

LABORATORY HYGIENE AND WASTE DISPOSAL

Under this heading the problems in manipulating relatively small "tracer" quantities of radioactive isotopes were considered, discussion being opened by the Delegate of France (Mons. Roux - for text see Supplement).

Although the elaborate and expensive protective equipment needed for handling large quantities of fission products are not necessary for agricultural research laboratories, some provision of a simpler kind is nevertheless very important. This was essential in order firstly to avoid personal radiation hazards above the maximum permissible level, and secondly to avoid contamination of the minute quantities of radioactive isotopes used in counting by the more active material (often "carrier-free") used in the early stages of all experiments.

A number of countries with experience in these matters were able to put forward constructive suggestions on such laboratory design and equipment as is necessary, and on methods of disposal of radioactive waste.

Attention is directed to the following publications on laboratory hygiene and waste disposal - Technical Secretary.

- "Safety Techniques for Radioactive Tracers" by J.C. Boursnell - to be published shortly by Cambridge University Press, England, - price about 7½ shillings.

- "The Protection of Personnel Working with Radioactive Materials and the Disposal of Radioactive Waste" by H.J. Dunster (Health Physics Division, Atomic Energy Research Establishment, Harwell, Berks, England) - reprinted from Medicine Illustrated, Vol.8, No.11, November 1954.

- "Radioisotopes in Biology and Agriculture" by C.L. Comar - published by McGraw Hill Book Co., London and New York (481 pp.) - Chapter on 'Health Physics and Radiation Protection.'

- The following U.S. National Bureau of Standards Handbooks are for sale by the Superintendent of Documents, U.S. Government Printing

SPECIAL NEW EXPERIMENTAL TECHNICS

Prof. van Wijk (Netherlands) referred to the large amount of isotopes which will be produced in atomic energy reactors and said that it would become important to find means for using these waste-products.

He demonstrated as one example an instrument using a source of radioactive material for measuring the density of hay in stacks. The instrument consists of a metal rod two meters long with a caesium source of 10 millicuries at one end and a counter mechanism at the other. The end of the rod which carries the caesium source is thrust into the stack until the counter registers one half of the value

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Office, Washington 25, D.C., U.S.A., at the price indicated:-

		Price
No. 41-	Medical X-ray Protection Up to Two Million Volts	-.25 cents
No. 42-	Safe Handling of Radioactive Isotopes	.15 "
No. 48-	Control and Removal of Radioactive Contamination in Laboratories	.15 "
No. 49-	Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users	.10 "
No. 50-	X-Ray Protection Design	.20 "
No. 51-	Radiological Monitoring Methods and Instruments	.15 "
No. 53-	Recommendations for the Disposal of Carbon-14 Wastes	.15 "
No. 54-	Protection against Radiations from Radium, Cobalt-60, and Caesium-137	.25 "
No. 57-	Photographic Dosimetry of X- and Gamma Rays	.15 "
No. 59-	Permissible Dose from External Sources of Ionizing Radiation	.30 "
No. 60-	X-Ray Protection	.20 "

registered in air. The rod is calibrated along its length and by noting the depth of insertion into the stack the density of the hay can be measured.

During the discussion, Prof. van Wijk said the moisture content of the hay was more or less constant and as the instrument was only intended to give an approximate measure of the density of the hay the errors introduced by changes in moisture content were unimportant.

A brief account was given by the Delegate of Portugal of a modification of the isotope dilution technique termed the "constant precipitate method" which is being used for phosphorus analysis and is adaptable to many other elements. Further particulars will be found in the Supplement.

COOPERATION ON THE INTERNATIONAL LEVEL

The Technical Secretary presented a brief review of international activities to promote the peaceful uses of atomic energy, and of arrangements by which the United Nations family of organizations ensures coordination of their respective programs.

Attention was directed to the need for an international list of available labelled compounds. It was reported that it is believed that the preparation of such a list is under consideration by UNESCO. The Contact Group considered that a list of this nature was urgently needed.

Special mention was made of the Radio-Chemical Center, Amersham, England, which has facilities for the preparation of labelled compounds necessary for work with isotopes. This Center is prepared to consider the possibility of synthesizing special labelled compounds on request.

The delegate of Sweden expressed willingness to investigate the possibility of representatives from other countries being invited to participate in a future Scandinavian meeting on the application of radiation in plant breeding and genetics. The Group was grateful for this suggestion and it was agreed that in general, cooperation of this nature could be further stimulated by the Contact Group.

The representative of OEEC presented a brief account of OEEC activities and in particular the EPA- Project No. 396 for promoting the use of atomic energy and its by-products in the production, processing and distribution of agricultural products. From this it appeared that the OEEC and FAO programs are complementary and that each could effectively reinforce the other.

The Contact Group learned with satisfaction of existing arrangements between FAO and OEEC for coordinating their respective programs in this field. The Contact Group attached great importance to the desirability of maintaining the present close cooperation with OEEC.

The Contact Group recognized that, as an intergovernmental body of experts, it could play an increasingly important role in future years, especially as plans mature for the establishment of inter-country cooperation in Europe in the civil uses of atomic energy.

The Group also stressed again the necessity of strengthening cooperation within countries as well. In some countries national cooperation on research problems in this field is already well organized, and other countries have plans to organize such cooperation. The Contact Group recommended that where no mechanism for national cooperation exists countries should consider the development of a national committee or other arrangements for strengthening contacts between all investigators concerned with the application of isotopes and radiation in agriculture.

With reference to comments made on the need for uniform methods of sampling and analysis of soil for content of radioactive materials, and the need for uniform reporting of data, the Technical Secretary reported that the United Nations Scientific Committee on the Effects of Atomic Radiation is giving consideration to these matters, and that WHO in association with FAO was considering the establishment of an Expert Committee to advise on methods of radiochemical analysis of biological materials, soils and water.

FUTURE WORK OF THE CONTACT GROUP

After a full discussion of the future work of the group in which many delegates participated, agreement was reached on the following points:

1. Another meeting of the entire Contact Group would probably not be necessary for some time, unless special circumstances require it.

2. In the meantime the Contact Group would continue to be active and special meetings or symposia should be organized in particular aspects of soil science, plant science, plant breeding, animal science, and the use of radiation in food preservation. Whenever possible, these meetings should be organized in connection with international meetings of professional societies which are held in Europe. As an example the delegate of Germany, with the support of the delegate of France, suggested that a symposium on the use of isotopes in soil fertility investigations be organized in association with the meetings of Commissions II and IV of the International Soil Science Society in Germany in 1958.

Such meetings should be kept to a moderate size to allow the fullest participation by members of the Contact Group. These meetings would follow the regular sessions of the congresses and invitations to participate would be issued by FAO to all governments represented on the Contact Group.

3. All members of the Group will endeavour to keep the Coordinator informed of new developments in their country. The Coordinator will circulate this information to the members of the Group from time to time.

4. At the next meeting of the Contact Group there will be a full discussion of means of improving the flow of information to research workers using isotopes and radiation in their investigations.

5. The Coordinator and FAO will endeavor, as opportunity permits, to circulate information on significant documents of general interest, especially those not likely to come to the attention of investigators through the usual scientific, abstracting and reviewing services.

6. Nominees to the Contact Group would act as liaison officers for their respective countries to whom requests for information and for assistance in making contacts with specialists in particular fields of investigation could be addressed. Such services, however,

were in no way intended to replace the valuable direct contacts between investigators working on common problems where those were possible.

TIME AND PLACE OF NEXT MEETING

The Contact Group agreed that a full meeting would probably not be necessary for some time unless special circumstances require it. The exact date of the next meeting would be decided by the Coordinator in consultation with FAO and members of the Contact Group.

Representatives of Denmark, the United Kingdom and Belgium kindly offered the facilities of their countries for future meetings organized under the auspices of the Contact Group. The United Kingdom delegate suggested Harwell as the place for any such meeting held in the United Kingdom.

In addition the United Kingdom delegate suggested Cambridge for the proposed symposium on research on the use of radiation in food preservation.

SUMMARY OF RECOMMENDATIONS

1. Governments should encourage intensified research through the use of isotopes in the many fields in which they can contribute to knowledge, among which the following may be quoted as examples:

   a) organic matter and nitrogen fertilizers in the soil, by use of ^{14}C and ^{15}N

   b) photosynthesis, ion intake, fungicides, insecticides and herbicides.

   c) animal metabolism, endocrinology, animal physiology and pathology.

2. Governments should encourage the use of ionizing radiations in crop breeding programs.

3. Consideration should be given to specific means of developing international cooperation in research in food preservation by irradiation.

4. Governments should take steps to make available adequate training opportunities in the use of isotopes and radiation in agricultural research, if necessary utilizing the training facilities of other countries.

5. FAO should prepare from the information presented at the meeting and additional information to be provided by the Contact Group, an index of institutions using isotopes and radiation in agricultural research, for circulation to the Contact Group.

6. In addition to meetings of the Contact Group, symposia should be organized in specialized aspects of the five broad categories of applications of isotopes and radiation considered at this meeting, whenever possible in association with the meetings of international scientific societies.

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Country statements on programs and plans for the use of isotopes and radiation in agricultural research are presented in a separate Supplement to this report.